

THE EFFECT OF TRACE ELEMENT DEFICIENCIES ON THE BOTRIVER PROTEA (*PROTEA COMPACTA*, R. BR.) IN WATER CULTURE†

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ABSTRACT

The effects were investigated of deficiencies of the trace elements boron, manganese, copper, molybdenum, and zinc on the growth of *Protea compacta* grown in water culture. Foliar deficiency symptoms developed for all elements but only deficiencies in the rooting medium of boron, copper and manganese had appreciable effects on amplifying growth.

INTRODUCTION

There have as yet, been few attempts to study the nutritional requirements of the members of the South African Proteaceae. Though some observations on *Protea cynaroides* have been published (van Staden, 1967, 1968) our knowledge is still very inadequate. Deficiency symptoms have seldom been recorded in plants growing in the wild and the only indication that the natural plant community in the Western Cape may suffer from malnutrition was reported by Schütte in 1960. The object of the present study was to assess the role of the trace elements boron, manganese, molybdenum, copper and zinc on the growth of one member of the Proteaceae.

MATERIAL AND METHODS

Fresh seeds of *P. compacta* R. Br. (obtained from the South African Forestry Department, Cape Town) were germinated in moist sand in the laboratory, and the seedlings transferred to 1.2 L glass containers before the first leaf appeared. They were grown on in a greenhouse between 12° and 39°C and were aerated for one hour every day. The cultures were arranged in a randomised block design with six replicates of each treatment.

There were six treatments, viz. complete mineral nutrients and solutions minus the trace elements boron, copper, manganese, molybdenum and zinc.

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The basic solution consisted of Hoagland and Arnon's (1950) No. 2 nutrient solution in de-ionised water. The micronutrient supplement contained 18 mg NaFe-EDTA, 1.0 mg B (as H_3BO_3), 1.0 mg Mn (as MnSO_4), 0.04 mg Cu (as CuSO_4), 0.1 mg Zn (as ZnSO_4), and 0.02 mg Mo (as $\text{H}_2\text{MoO}_4 \cdot \text{H}_2\text{O}$), per litre of solution. The containers were refilled with fresh nutrient solution every two weeks. In addition the level of the solution was kept constant by the frequent addition of de-ionised water.

The plants were harvested eight weeks after transferring the seedlings to the containers, and the total length of the stem, number of leaves, shoot dry weight and root dry weight were then recorded.

RESULTS AND DISCUSSION

The development of deficiency symptoms and the descriptions of these symptoms for each element tested are given in Table 1. The symptoms in all cases appeared more or less at the same time, approximately one month after transplanting. A typical plant, grown in the absence of copper, is illustrated in Plate 1.

TABLE 1
The development of symptoms of trace element deficiencies in *Protea compacta*

Treatment	No. of days from transplanting	Symptoms
—B	34	Leaves slightly distorted and curled, the intervenal areas tinted purple. Older leaves dying from the tips.
—Cu	34	Young leaves failed to unroll. Old leaves became slightly chlorotic and severely wilted, followed by necrosis.
—Zn	35	Leaves chlorotic at intervenal areas as well as malformed.
—Mo	42	Leaf tips became necrotic.
—Mn	43	Purple spots appeared on leaves in a mottled pattern. In some cases the leaf tips died.
		Leaf tips became chlorotic and necrotic areas appeared next to the main veins.

The effects of deficiencies of the various nutrients on plant yield are given in Table 2. Deficiencies of molybdenum and zinc had no significant effect on any of the growth characteristics measured. Manganese deficiency resulted in a significant decrease in shoot weight and root weight, but not in stem length or the number of leaves. Deficiency of the other two elements, boron and copper, had significant effects on all of the characteristics measured. It is of interest that these results are in accordance with the findings of Moore and Keraitis (1966) on *Grevillea*. They found that "absence of copper, molybdenum,

or zinc had no measurable effect on growth of the seedlings. Boron deficiency caused a significant reduction in height and leaf weight, and manganese deficiency significant reductions in height, stem diameter, stem weight, leaf weight, and root weight." The present results are also similar to those previously reported in a variety of other plants (Wallace, 1961.)

TABLE 2
 Effect of trace element deficiencies on the growth of *P. compacta*

	Treatment						L.S.D.
	Control	—B	—Cu	—Mn	—Mo	—Zn	P = 0.05
Number of leaves	25.8	19.8	10.7	21.1	22.0	21.0	4.57
Stem length (cm). . . .	9.81	6.13	6.21	7.21	7.18	9.23	3.07
Dry weight of shoots (mg) .	194	132	131	123	165	174	61
Dry weight of roots (mg). .	62	45	42	39	62	60	5

It is also of further interest that, as was found to be the case with the major nutrient elements (van Staden, 1968), this species is very sensitive to variation in the trace element supply. As can be seen from Table 1 all the treatments brought about signs of malnutrition between 34–42 days after commencing the treatments. This is in spite of the presence of large cotyledons, which might provide a temporary source of trace elements. After four months of growth in the absence of trace elements, *Grevillea robusta* (Moore and Keraitis, 1966) showed deficiency symptoms only on plants not receiving boron and manganese, while the other plants were normal.

One of the purposes of the experimental work described above was to record the symptoms of trace element deficiencies as developed in *P. compacta*. This information may contribute to the recognition of deficiency symptoms in plants in the field. However, the data reported here was obtained from very young plants and may not be directly applicable to mature plants, although in view of the findings of Schütte (1960), such an extension appears to be justified.

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